BOARD BRIEFING ON FINAL REPORT

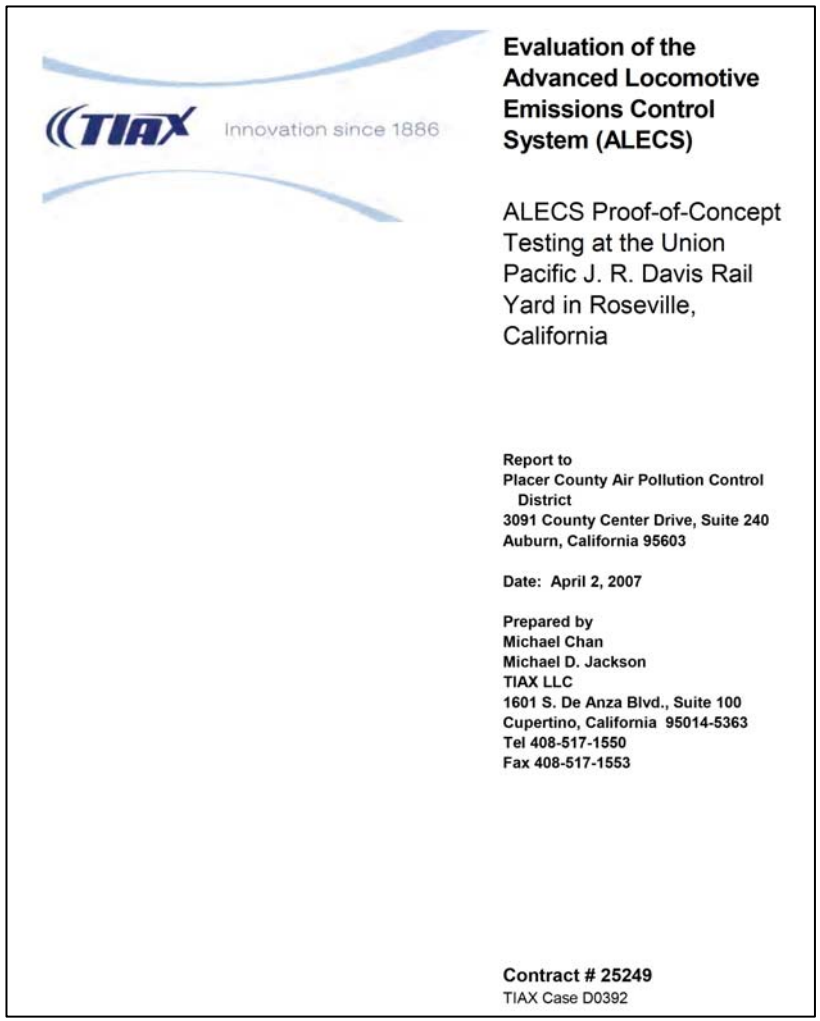
ADVANCED LOCOMOTIVE EMISSION CONTROL SYSEM

PROOF-OF-CONCEPT TEST PROGRAM

April 12, 2007

Don Duffy
Associate Air Quality Engineer
Placer County Air Pollution Control District

FINAL REPORT COVER PAGE



TIAX Innovation since 1886

Evaluation of the Advanced Locomotive Emissions Control System (ALECS)

ALECS Proof-of-Concept Testing at the Union Pacific J. R. Davis Rail Yard in Roseville, California

Report to
Placer County Air Pollution Control District
3091 County Center Drive, Suite 240
Auburn, California 95603

Date: April 2, 2007

Prepared by
Michael Chan
Michael D. Jackson
TIAX LLC
1601 S. De Anza Blvd., Suite 100
Cupertino, California 95014-5363
Tel 408-517-1550
Fax 408-517-1553

Contract # 25249
TIAX Case D0392

EVOLUTION OF THE HOOD PROOF-OF-CONCEPT PROJECT

- Roseville citizens' complaints to District about rail yard noise, emissions and health risk
- CARB initiated HRA at request of PCAPCD in 2001
- HRA completed late 2004 shows significant risk from DPM
- UPRR agreement in Dec. 2004 provides for mitigation measures and air monitoring
- Mitigation measures defined in April 2005, including investigating stationary control equipment for locomotives

EVOLUTION OF THE HOOD PROOF-OF-CONCEPT PROJECT (CONTINUED)

- District was researching possible approaches since early 2004
- West Coast Diesel Collaborative (WCDC) grant RFP in early 2005 was catalyst to organize a proof-of-concept project
- Found that ACTI was working on a similar strategy, but for a marine application
- Awarded a small grant from WCDC in September, 2005

EVOLUTION OF THE PROJECT TEAM

- Original team members were PCAPCD, UPRR, ACTI, and SMAQMD
- SCAQMD joined the project team , contributing the cost of the emissions testing
- EPA became active in the project and contributed to development of the test protocol
- CARB joined the team and aided in the test protocol development
- City of Roseville joined the team and contributed to the media event.

EVOLUTION OF THE PROJECT TEAM

Final Project Team

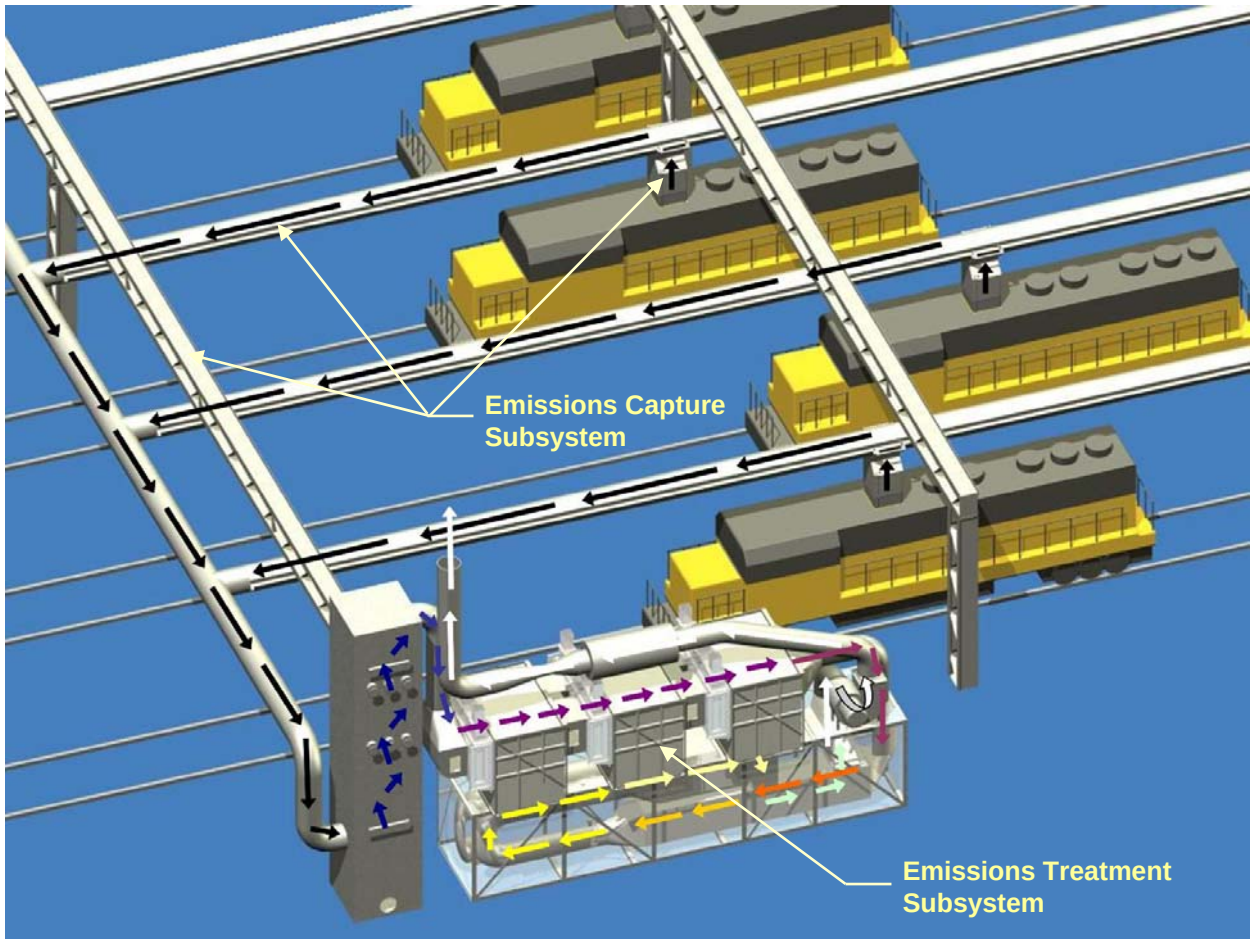
PARTICIPANT	CONTRIBUTION	TYPE
U.S. EPA	$39,000	Dollars + technical
Air Resources Board	--	In-kind technical
PCAPCD	$100,000	Dollars + tech & project mgmt.
SMAQMD	$25,000	Dollars
SCAQMD	$50,000	Dollars
UPRR	$200,000	In-kind
ACTI	$1,300,000	In-kind
City of Roseville	$10,000	Dollars + in-kind

PROJECT OBJECTIVES

- Demonstrate the effectiveness of stationary control equipment on locomotive exhaust
- Demonstrate the attachment scheme between the locomotive and the stationary control equipment
- Demonstrate the capability of some locomotive movement while connected to the control equipment
- Develop improved information on capital cost, operating procedures, and operating costs
- Document test results and project findings in a final report

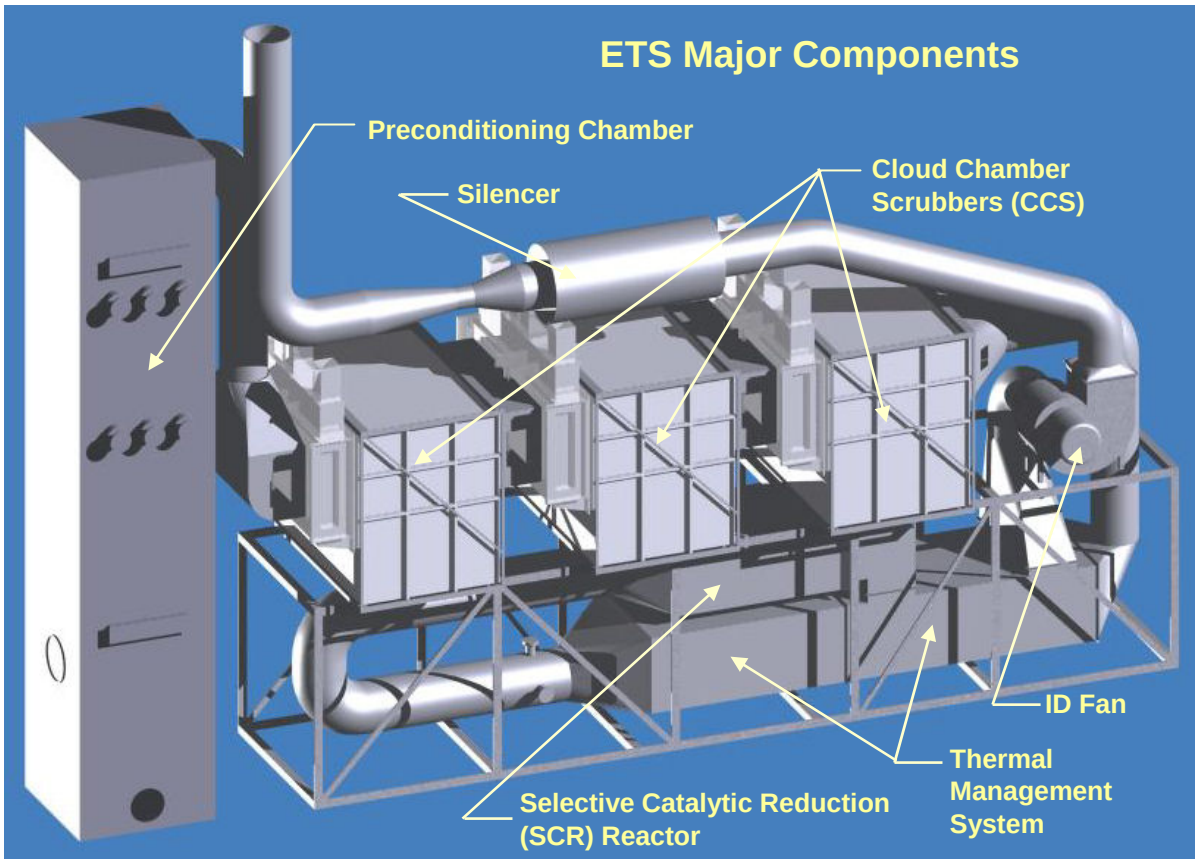
HOW THE ALECS WORKS

Rail Yard Concept



HOW THE ALECS WORKS

Emissions Treatment Subsystem



HOW THE ALECS WORKS

Picture of Emissions Treatment Subsystem

HOW THE ALECS WORKS

Double Stack GP38 Switcher

HOW THE ALECS WAS TESTED

- Exhaust stream sampled at 3 locations
- Two locomotive types tested
- PM tests
  - ISO 8178
  - PM 2.5 cyclone
  - Teflon and quartz filters
  - Quartz for monitoring project organic/elemental carbon determination

HOW THE ALECS WAS TESTED (CONTINUED)

Inlet Measurement Location

HOW THE ALECS WAS TESTED (CONTINUED)

Outlet Measurement Location

HOW THE ALECS WAS TESTED (CONTINUED)

Dash-8 Locomotive

HOW THE ALECS WAS TESTED (CONTINUED)

Test Locomotive Characteristics

	Locomotive	
	Dash-8	**GP38**
Locomotive Service Class	Line-haul	Switcher
Locomotive Model	GE C39-8	EMD GP38
Locomotive Identification Number	9143	604
Engine Model	GE FDL-16	EMD 16-645E
Engine Type	Four-stroke	Two-stroke
Number of Cylinders	16	16
Rated Power Output (horsepower)	3,900	2,000
Number of Exhaust Stacks	1	2
Maximum Exhaust Flow Rate	12,000 scfm	6,000 scfm

HOW THE ALECS WAS TESTED (CONTINUED)

Source of Emission Measurements by Sampling Location

	Locomotive Stack	ALECS Inlet	ALECS Outlet
NOx	R	R, A	R, A
THC	—	A	A
CO	—	R	R
CO_2	R	R	R
SO_2	—	A	A
NH_3	—	—	A, FTIR
N_2O	—	FTIR	FTIR
PM	R	R	R

A = ALECS CEM system equipment
R = RAVEM system equipment
FTIR = Fourier Transform Infrared

HOW THE ALECS WAS TESTED (CONTINUED)

Summary of Planned Tests

Locomotive	Throttle Notch	Number of Tests at Location		
		Locomotive Stack	ALECS Inlet	ALECS Outlet
Dash-8	8	3	3	3
	5	3	3	3
	1	3	3	3
	3(soup baseline)	3	3	3
	3(souping test)	3	3	3
	Moving	3	3	3
GP38	8	3	3	3
	5	3	3	3
	1	3	3	3
	3(soup baseline)	3	3	3
	3(souping test)	3	3	3
	Moving	3	3	3

TEST RESULTS

Average Control Efficiencies of the Major Pollutants

Locomotive	Throttle Notch	NOx	THC	PM	SO2
Dash-8	8	96.8%	32.9%	88.8%	99.7%
	5	98.4%	31.4%	80.9%	100.0%
	1	98.1%	57.6%	98.6%	99.1%
	3 (soup baseline)	100.0%	33.2%	90.7%	100.0%
	3 (souping test)	97.0%	51.4%	97.0%	99.2%
	Moving	98.7%	56.0%	98.5%	100.0%
GP38	8	98.6%	73.2%	90.7%	100.0%
	5	99.3%	85.7%	90.7%	100.0%
	1	97.0%	83.1%	89.6%	88.4%
	3 (soup baseline)	98.4%	84.9%	90.8%	100.0%
	3 (souping test)	95.2%	84.2%	94.9%	96.0%
	Moving	96.3%	78.6%	93.5%	84.9%
Overall Average Control Efficiency		**97.8%**	**62.7%**	**92.1%**	**97.3%**

TEST RESULTS

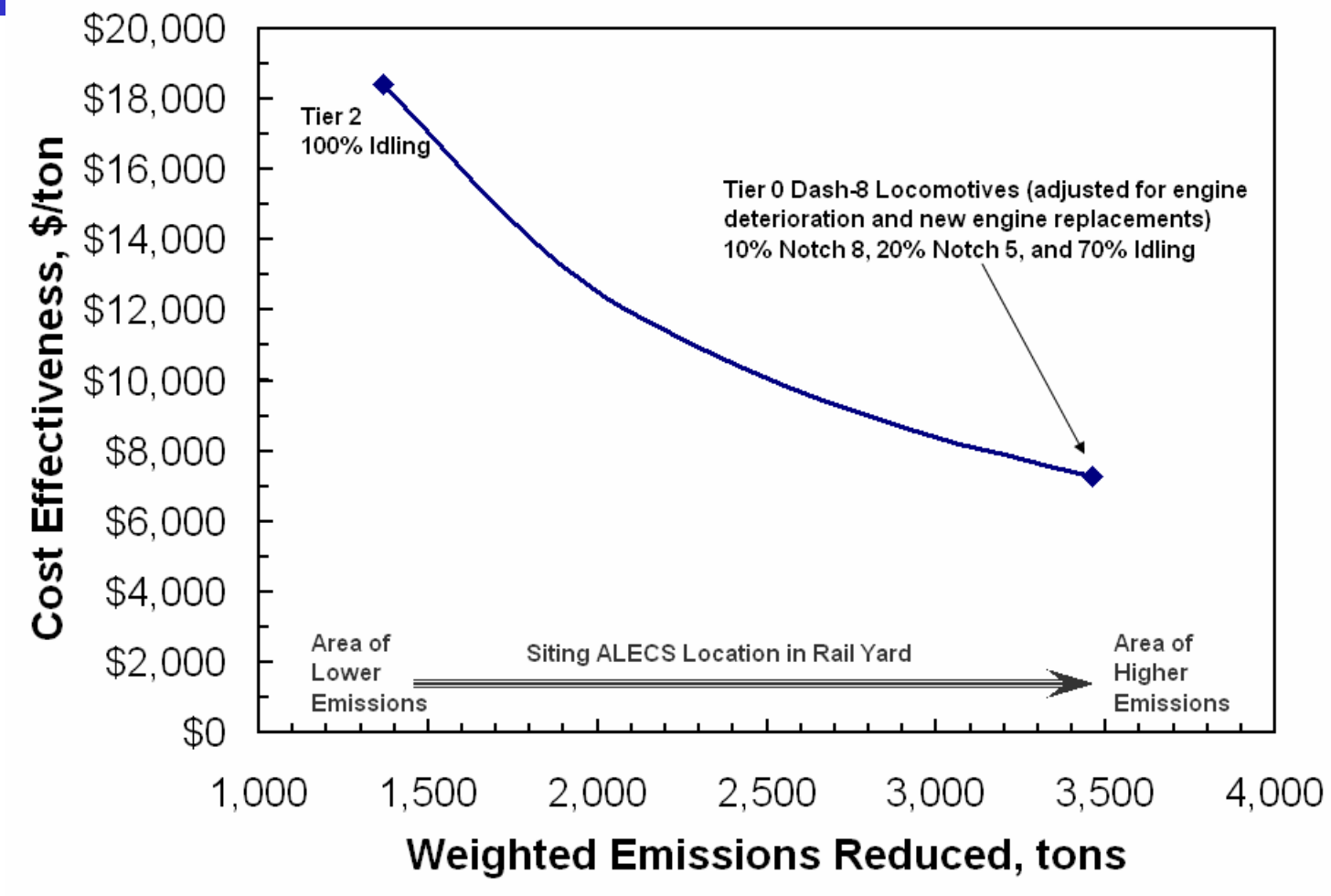
Noise Measurements With/Without Bonnet in Place

	Average Sound Level (decibels)			Percent Reduction in Sound Energy
	w/o Bonnet	w/Bonnet	Reduction	
DASH-8: Notch 8	87	81.7	5.3	70%
DASH-8: Notch 5	84.5	77.7	6.8	79%
GP38: Notch 8	91.6	84.8	6.8	79%

LIFE CYCLE COST ANALYSIS

- 20-Year life
- 96% System utilization
- Total capital investment--$8,680,126
- Annual operating costs--$955,866
- PM-10 valued at 20 X
- Cost effectiveness--$8,000/ton to $18,000/ton

LIFE CYCLE COST ANALYSIS



CONCEPT OF NEXT STEPS